

Terahertz Frequency Metamaterial Devices

Willie J. Padilla,

Department of Physics, Boston College, Chestnut Hill, MA 02467, USA.

Metamaterials achieve a functional electromagnetic response exceeding that possible with natural materials. Furthermore, this resonant metamaterial response can be designed to occur at nearly any region of the electromagnetic spectrum. Metamaterials therefore extend natural materials in terms of device designs and performance. Notably, the THz range (100 GHz - 4 THz) of the electromagnetic spectrum is void of suitable materials from which to form the basic components crucial to THz technology (detectors, switches, modulators, filters), even though there are a myriad of proposed applications. Metamaterials are promising candidates to correct for this lack of material response.

Here we show metamaterial devices capable of real-time control and manipulation of THz radiation. Modulation of the THz transmission is accomplished both by optical and electronic control of substrate properties. We demonstrate a 50% modulation of the THz transmitted intensity and achieve switching recovery times as fast as 20 picoseconds. This observed performance indicates that metamaterial devices have significant potential to bring to fruition near term THz devices demonstrating significant improvement in comparison to the existing state-of-the-art.